

**UTILITY OF AMINOCYCLOPYRACHLOR FOR CONTROL OF HORSENETTLE
AND TALL IRONWEED IN COOL-SEASON GRASS PASTURES**

A thesis

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ABSTRACT

Previous research has shown that management of horsenettle (*Solanum carolinense*) and tall ironweed (*Vernonia gigantea*) in cool-season grass pastures and hayfields is difficult. Therefore, research was conducted at Alcoa, Fork Creek, Greenback, Maynardville, and Pulaski, Tennessee, and at London, Kentucky, in 2010 and 2011 to examine efficacy of aminocyclopyrachlor on these two perennial weeds. Research was conducted on naturally-occurring infestations of each weed. Treatments were: aminocyclopyrachlor (49 g ai/ha) with and without 2,4-D amine (371 g ai/ha), aminocyclopyrachlor (98 g ai/ha) with and without 2,4-D amine (742 g ai/ha), and aminopyralid (88 g ai/ha). Treatments were applied at three postemergent (POST) timings to horsenettle, which corresponded to horsenettle in a vegetative (EPOST), flowering (MPOST), or fruit-setting (LPOST) growth stage. Treatments were applied at two POST timings to tall ironweed, when ironweed was either vegetative (EPOST) or flowering (LPOST). Analysis of this RCB was conducted utilizing ANOVA in SAS. Means were separated using Student-Newman-Keuls.

Treatment effects were found to be significant for visual weed control, weed density, and height ($P < .05$). Year-after control of horsenettle was found to be as high as 81% with a LPOST application of aminocyclopyrachlor at 98 g ai/ha with 2,4-D at 742 g ai/ha. Equivalent control was achieved with aminocyclopyrachlor at other rates applied MPOST and LPOST, and with aminopyralid at 88 g ai/ha applied MPOST. Tall ironweed was controlled 99% 1 YAT with aminocyclopyrachlor at either timing at rates as low as 49 g ai/ha, while aminopyralid applied LPOST at 88 g ai/ha provided 96% control. Both aminocyclopyrachlor and aminopyralid were found to significantly reduce horsenettle and tall ironweed biomass the following year.

The best year-after control of horsenettle (~80%) was achieved with aminocyclopyrachlor LPOST and aminopyralid applied MPOST. The best year-after control of tall ironweed (>96%) resulted from LPOST applications of aminocyclopyrachlor or aminopyralid. Therefore, a late-summer application, when there is adequate soil moisture, would be optimal for control of horsenettle and tall ironweed with aminocyclopyrachlor. A dose of at least 98 g ai/ha would be recommended to control horsenettle; tall ironweed could be controlled at rates as low as 49 g ai/ha.

TABLE OF CONTENTS

Chapter I: Introduction	1
Chapter II: Literature Review	3
Horsenettle	3
Tall Ironweed	9
Aminocyclopyrachlor	14
Chapter III: Utility of Aminocyclopyrachlor for Control of Horsenettle and Tall Ironweed in Cool-season Grass Pastures	15
Materials and Methods	15
Horsenettle Results and Discussions	17
Tall Ironweed Results and Discussions	25
Conclusions	30
References	33
Appendix	37
Vita	63

LIST OF TABLES IN APPENDIX

Title of Table	Page
3.1 Horsenettle Treatments	38
3.2 Tall Ironweed Treatments	38
3.3 Application Dates of Horsenettle and Tall Ironweed Studies in 2010 and 2011	38
3.4 Weather Data for Knoxville, TN	39
3.5 Weather Data for Huntsville, AL	39
3.6 Weather Data for London, KY	39
3.7 Weather Data for Tazewell, TN	39
3.8 Utility of Aminocyclopyrachlor for Control of Horsenettle, Alcoa, TN 2010, EPOST Timing	40
3.9 Utility of Aminocyclopyrachlor for Control of Horsenettle, Alcoa, TN 2010, MPOST Timing	40
3.10 Utility of Aminocyclopyrachlor for Control of Horsenettle, Alcoa, TN 2010, LPOST Timing	40
3.11 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, End of Season, Alcoa, TN	41
3.12 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, 1 YAT, Alcoa, TN	42
3.13 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2010, EPOST	43
3.14 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2010, MPOST	43
3.15 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2010, LPOST	43
3.16 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, End of Season, Fork Creek, TN	44
3.17 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, 1 YAT, Fork Creek, TN	45
3.18 Utility of Aminocyclopyrachlor for Control of Horsenettle, Greenback, TN 2010, EPOST	46
3.19 Utility of Aminocyclopyrachlor for Control of Horsenettle, Greenback, TN 2010, MPOST	46
3.20 Utility of Aminocyclopyrachlor for Control of Horsenettle, Greenback, TN 2010, LPOST	46
3.21 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, End of Season, Greenback, TN	47
3.22 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, 1 YAT, Greenback, TN	48
3.23 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2011, EPOST	49
3.24 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2011, MPOST	49
3.25 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2011, LPOST	49
3.26 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2011, End of Season, Fork Creek, TN	50
3.27 Utility of Aminocyclopyrachlor for Control of Horsenettle, Maynardville, TN 2011, EPOST	51
3.28 Utility of Aminocyclopyrachlor for Control of Horsenettle, Maynardville, TN 2011, MPOST	51
3.29 Utility of Aminocyclopyrachlor for Control of Horsenettle, Maynardville, TN 2011, LPOST	51
3.30 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2011, End of Season, Maynardville, TN	52
3.31 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2010, EPOST	53
3.32 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2010, LPOST	53
3.33 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, End of Season, London, KY	54
3.34 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, 1 YAT, London, KY	54
3.35 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2010, EPOST	55
3.36 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2010, LPOST	55
3.37 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, End of Season, Pulaski, TN	56
3.38 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, 1 YAT, Pulaski, TN	56
3.39 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2011, EPOST	57
3.40 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2011, LPOST	57
3.41 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2011, End of Season, London, KY	58
3.42 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Maynardville 2011, EPOST	59
3.43 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Maynardville 2011, MPOST	59
3.44 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Maynardville 2011, LPOST	59
3.45 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2011, End of Season, Maynardville	60
3.46 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2011, EPOST	61
3.47 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2011, LPOST	61
3.48 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2011, End of Season, Pulaski, TN	62

CHAPTER I

INTRODUCTION

Livestock production in Tennessee has a long and storied history, and remains a key component in the state economy, with beef cattle being the largest sector (Womack 2012). Over the last several years, cattle producers, along with other agriculture producers, have been forced to cope with steadily rising input costs. Cattle prices have not, in most instances, risen enough to absorb the increased costs of feed, fuel, and fertilizer (B. B. Greene, personal communication, 2011). In order to remain economically viable, cattle producers have turned their attention to increasing the efficiency of their grazing and hay operations. Rotationally grazing small paddocks has gained popularity over the traditional method of continuously grazing a group of cattle in a larger area, because rotational grazing allows the cattle to more efficiently utilize the forage. This method can also increase the carrying capacity of an area. Likewise, greater emphasis has been given to properly timed hay harvest and dry hay storage to minimize losses due to decreased nutritive value and storage losses (G. E. Bates, personal communication, 2011). With such emphasis on maximizing the production of every acre, a field with significant weed pressure is no longer acceptable. Weeds compete successfully with forage grasses for limited resources, thereby decreasing forage yield and quality (Bradley and Kallenbach 2005). Producers must be able to effectively control weeds in their hayfields and pastures to remain economically viable in the current economic situation.

Management of some perennial pasture weeds has been very difficult or impossible with traditional pasture herbicides, clipping, or grazing, due to natural tolerance of those plants to many herbicides, the ability of those plants to store ample carbohydrates in roots and/or rhizomes

for improved survival under stressful conditions, and the fact that most grazing animals avoid them (Beeler et. al 2004, Bradley and Kallenbach 2005, McCarty and Linscott 1963, Peters and Lowance 1978). This can lead to weed population increase in pastures and hayfields. Two such troublesome weeds in Tennessee pastures and hayfields are horsenettle (*Solanum carolinense* L.) and tall ironweed (*Vernonia gigantea* (Walt.) Trel.) (G. N. Rhodes, personal communication, 2010). The objective of this research is to identify the optimum rate and application timing of aminocyclopyrachlor, a new herbicide currently undergoing EPA registration, for control of horsenettle and tall ironweed in cool-season grass pastures, and to compare its efficacy with that of aminopyralid.

CHAPTER II

LITERATURE REVIEW

Horsenettle *Solanum carolinense* L.

Botanical Description

Solanum carolinense L., commonly known as horsenettle or bullnettle and previously called Carolina horsenettle, is a perennial herbaceous plant native to the southeastern United States (Vallejo-Marin and Rausher 2007). It is a member of the Solanaceae family. It has an erect stem growing to a maximum height of 1 m. The stem will become thickened and woody with age, and may be deep purple in color. The stem is covered in short stiff trichomes; prickles will also be found on mature stems. The root system of horsenettle consists of a taproot (from which fibrous roots arise) and creeping rhizomes. The leaves of horsenettle are alternate, 7-12 cm long, 3-8 cm wide, simple, petioled, crowded, and elliptic-oblong to oval, with deep green adaxial surfaces and paler abaxial surfaces. Leaf margins are either undulate or lobed. Both leaf surfaces are covered with sessile star-shaped trichomes. There are prickles on the midveins and petioles. Star-shaped white or pale violet inflorescences are borne in raceme-like clusters (Bryson and DeFelice 2009). Individual plants are andromonecious, having both staminate and perfect flowers on each plant (Okey et al. 2000; Vallejo-Marin and Rausher 2007). Berries are round, 1 to 1.5 cm in diameter, and ripen from green to yellow (Bryson and DeFelice 2009).

Distribution, Biology, and Physiology

Horsenettle can be found throughout the eastern United States, in the Midwest, and in the far western contiguous states. It is often found in disturbed areas, row crop fields, pastures, roadsides, waste sites, and open woodlands. It spreads both by seeds and by rhizomes (Bryson and DeFelice 2009).

Management

Cultural

Because horsenettle is able to produce new shoots from small root sections, mechanical cultivation is not an effective means of control. Cultivation can exacerbate the weed problem by turning the rhizome of one shoot into a propagation device for many shoots by breaking underground bud dormancy. In addition, the carrying of root material on tillage implements may spread a horsenettle infestation across a field (Beeler et al. 2004; Nichols et al. 1992; Whaley and Vangessel 2002). Since the plant stores most of its carbohydrates underground in the root system, effective control by mowing requires complete depletion of reserves. However, Ilnicki and Fertig (1962) found that horsenettle mowed frequently at very low heights would eventually form a rosette growth pattern and would thus keep the root system sufficiently supplied with carbohydrates.

Biological

Limited research has been conducted on practical biological controls for horsenettle in agricultural crops. However, a study by Nichols et al. (1992) looked for insects, nematodes, and pathogens that might be used for horsenettle control in various cropping situations. Over a two year period, they sought out insects, nematodes, and pathogens in two bermudagrass pastures

that were heavily infested with horsenettle. The most commonly observed insect on horsenettle was the Colorado potato beetle, *Leptinotarsa decemlineata*, however no attempt was made to quantify the damage caused by this insect, although it appeared to be fairly minimal. Also, considering this pest feeds on many agricultural crops, its use as a beneficial biological control for horsenettle would be severely limited or nonexistent. The only other insect observed to cause much measureable damage was an unidentified member of the order Lepidoptera. The larval stage of this insect feeds on tissue near the floral apices of the horsenettle plant, and apices with feeding damage do not bear fruit. This presumably reduces seed production. However, the researchers were unable either to further identify this insect or to raise it in captivity (Nichols et al 1992).

Two pathogens were found to affect horsenettle during the above mentioned study. A *Rhizoctonia* sp. root rot was found on horsenettle growing in wet areas. However, the bermudagrass roots in those same areas was also infected with a *Rhizoctonia* sp. A downy mildew caused by *Erysiphe cichoracearum* DC. was found on horsenettle in the fall. Nichols et al. (1992) suggested that wide-spread tissue coverage with this downy mildew could reduce photosynthesis in the fall, when horsenettle are storing carbohydrates in the roots, but because environmental conditions would have to be ideal for this pathogen to infect plants, its use as a control would likely be highly limited.

Chemical

Extensive research has been conducted regarding herbicidal control of horsenettle. However, no one herbicide or group of herbicides has been found to be effective in all situations. Much of the research has centered on suppression rather than eradication of horsenettle.

Some synthetic auxin herbicides, which are symplastically translocated, are active on horsenettle. These herbicides cause cell wall loosening, unchecked cell elongation, and non-differentiated meristem-like cell division (Senseman 2007). The most common of the group is 2,4-dichlorophenoxyacetic acid (2,4-D). However, 2,4-D alone has not been shown to be effective in controlling horsenettle. Horsenettle control with 2,4-D alone at 140 g ai/ha gave less than 50% control in one study by Armel et al. (2003). In addition, they found that the addition of 2,4-D to mesotrione did not increase the efficacy of mesotrione. In fact, the addition of 2,4-D slightly decreased the control of the treatment over mesotrione alone at 105 g ai/ha (Armel et. al 2003). When Gorrell et. al (1981) evaluated horsenettle control in pastures after three annual applications of 2,4-D at 0.8 kg/ha, they found that shoot density was reduced about 80%, compared to >95% with three annual applications of picloram or triclopyr. Likewise, Albert (1960) reported that three annual applications of 2,4-D at 4 lb/ac failed to eliminate horsenettle in pastures. 2,4-D is available in many package mixes. Beeler et. al (2004) found greater than 95% control of horsenettle when using a 4:1 ratio of 2,4-D amine and picloram at 0.7 and 1.4 kg ai/ha sprayed early- and mid-postemergence. Due to the lack of action of 2,4-D, the control can be attributed to the picloram in the mixture.

Dicamba, another synthetic auxin herbicide, has shown some activity on horsenettle. Matthiesen and Santelmann (1972) reported that dicamba could be effective for one-season control. Banks and Santelmann (1978) found 90% control of horsenettle 84 days after treatment and 80% control 389 days after treatment at 6.7 kg/ha when it was applied subsurface layered. Whaley and Vangessel (2002) reported 79 to 90% control 11 weeks after planting when dicamba was applied the previous fall in row crop situations. Rates were 0.6, 1.1 and 2.2 kg ai/ha. However, Armel et al. (2003) reported less than 60% control when rates were reduced to 140 g

ai/ha in corn. Tank mixing dicamba with other herbicides has been shown to improve horsenettle efficacy of some while decreasing the efficacy of others (Armel et al. 2003).

Picloram, another synthetic auxin herbicide, has been shown to be effective on horsenettle. Beeler et al. (2004) reported greater than 95% control of horsenettle for one season when picloram was applied with 2,4-D to actively growing plants smaller than 25 centimeters in height that had not begun to flower. Picloram was applied as a package mix with 2,4-D at 0.7 and 1.4 kg ae/ha. Control the following year was between 47 and 66% when compared to the untreated checks (Beeler et al. 2004). Picloram has also been evaluated as a subsurface layered herbicide in row crop situations, and has been shown to provide up to 100% control of horsenettle 84 days after treatment at rates as low as 0.6 kg/ha. This rate of picloram also provided 90% control of horsenettle 389 days after treatment. Rates of 1.1 kg/ha or higher were reported to provide 100% control 389 days after treatment (Banks and Santelmann 1978).

The dinitroaniline herbicides have also been studied for horsenettle control in subsurface layered applications. Dinitroaniline herbicides inhibit mitosis by interfering with the formation of microtubules during cell division (Senseman 2007). In one study, at 82 days after treatment, trifluralin gave 90% control at a rate of 3.4 kg/ha. Profluralin provided 80% control of horsenettle when applied at 4.5 kg/ha. Dinitramine also provided 80% control of horsenettle at 2.2 kg/ha. However, at 130 days after treatment, all three herbicides provided less than 50% control. The addition of sequential applications of 2,4-D seemed to extend dinitroaniline efficacy (Banks and Santelmann 1978).

Mesotrione is a carotenoid biosynthesis inhibitor that inhibits the enzyme 4-hydroxyphenyl-pyruvate dioxygenase (Senseman 2007). Armel et al. (2003) reported the efficacy mesotrione for controlling horsenettle in no-till corn. At 105 g ai/ha, mesotrione

provided > 80% visual control at five weeks after treatment. In addition, mesotrione reduced horsenettle shoot populations by one third, and reduced biomass by 90% eight weeks after treatment. Additions of 2,4-D, dicamba, or rimsulfuron did not improve horsenettle control over mesotrione alone (Armstrong et al. 2003).

Acetolactate synthase (ALS) inhibitor herbicides of the sulfonylurea group have been successfully used to control emerged horsenettle in corn when tank-mixed with other materials. Primisulfuron at 20 g ai/ha has provided greater than 80% visual control of horsenettle when applied with 140 to 150 g ai/ha of dicamba (Armstrong et al. 2003; Whaley and Vangessel 2002). Halosulfuron at 56 g ai/ha applied with 140 g ai/ha of dicamba gave 78% visual control. Nicosulfuron at 13 g ai/ha applied with 13 g ai/ha of rimsulfuron, 756 g ai/ha of atrazine, and 140 g ai/ha of dicamba controlled horsenettle 72%.

In row crop situations, glyphosate has been proven effective in reducing horsenettle populations. Whaley and Vangessel (2002) showed that fall applications of glyphosate to horsenettle at a maturing fruit stage and heights of 13 to 48 centimeters would reduce horsenettle occurrence the following spring. At rates as low as 1.1 kg ai/ha, October-applied glyphosate provided 85 to 92% control in June over the untreated checks. Glyphosate was also shown to reduce the height and biomass of horsenettle. Fall applications of glyphosate also increased the effectiveness of in-crop postemergence treatments. It was noted that control was better when the material was applied before the horsenettle began senescing in the late fall (Whaley and Vangessel 2002).

Aminocyclopyrachlor, a recently discovered synthetic auxin herbicide, has shown some promise in controlling horsenettle and several other harder to control weeds. Excellent control of horsenettle was reported when aminocyclopyrachlor was applied at 1 oz ai/ac (Rhodes 2010).

Tall Ironweed
Vernonia gigantea (Walt.) Trel.

Botanical Description

Vernonia gigantea (Walt.) Trel. is a warm season, perennial herbaceous plant native to North America. It is known by the common names tall ironweed and giant ironweed. It can grow to a height of 3 m. Tall ironweed is a member of the Asteraceae or sunflower family. When it first emerges, the cotyledon leaves are oblong, and the first true leaves are oblanceolate to obovate. When mature, leaves are alternate, 6 to 30 cm long, and 4 cm wide or narrower. The leaves are lanceolate in shape and are tapered at both ends; they have serrated leaf margins, a white midrib, and trichomes on the abaxial leaf surface. The stem grows upright and remains unbranched until near the top of the plant. The stem is covered in trichomes, and is dark red when mature. Tall ironweed has characteristic reddish to purple flowers borne in spreading inflorescences at the terminal end branches. The fruit are 3 to 4 mm long, cylindrical in shape, and have longitudinal grooves. The fruit may be light tan to purplish brown, depending on stage of maturity. The root system of a mature ironweed plant consists of a fibrous taproot and rhizomes, making the plant rather difficult to uproot (Bryson and DeFelice 2009).

Distribution, Biology, and Physiology

Tall ironweed is a native species found throughout the eastern United States. It can be found in disturbed areas, roadsides, and pastures. It grows across a range of habitats and is especially tolerant of wet soils. It reproduces by seeds and rhizomes. Because most livestock avoid it, tall ironweed can spread easily in pastures (Bryson and DeFelice 2009; Marshall et al. 2006).

Management

Cultural

In a pasture situation, few cultural controls for tall ironweed have been studied. McCarty and Linscott (1963) reported that 9 consecutive years of annual and biannual mowing reduced western ironweed (a closely related *Vernonia* species) biomass by 40 to 50 % in the ninth year. Nine consecutive years would be considered by most producers to be too much time to invest in a control program that results in only 50 % biomass reduction. Biomass would likely rapidly increase again after mowing pressure is ended. In another study dealing with western ironweed, better control was achieved with a multiple mowing beginning in May, when the root carbohydrates levels should be at their yearly low-point (Peters and Lowance 1978). Mann et al. (1983) reported that if tall ironweed plants coming from seed were cut before they were 3 to 4 weeks old, regrowth would not occur.

Biological

At present, no specific insect pests, plant diseases, or viruses have been reported to provide potential for tall ironweed control.

Chemical

Chemical control shows more promise for cost effective tall ironweed control when compared with other methods. However, less research has been conducted for chemical control of tall ironweed than for some other troublesome, more common weeds, such as horsenettle. (This may be due to fact that tall ironweed is less prevalent, especially in row crop situations,

than horsenettle. Also, suitable research sites with uniform tall ironweed density may be difficult to find.) Previous research indicates that tall ironweed is susceptible to several synthetic auxin herbicides.

One of the most commonly used pasture herbicides, 2,4-D, has been shown to provide some control of ironweed species. McCarty and Linscott (1962) examined western ironweed control with 2,4-D and found that, when it was applied in early- to mid-summer, it reduced shoot density. They reported greater than 84% visual control. Mann et al. (1983) compared two different ester formulations and one amine formulation of 2,4-D. They reported the greatest visual control and the least regrowth with 2.2 kg/ha of the propylene glycol butyl ether ester form of 2,4-D, giving greater than 97% control and less than 20% regrowth. The butoxyethanol ester of 2,4-D at 1.7 kg/ha gave nearly as good control, with 92% control and less than 25% regrowth (Mann et al 1983). Several 2,4-D-containing products and tank mixes with 2,4-D also provide good control (greater than 80%) of tall ironweed (Bradley and Kallenbach 2005; Fryman and Witt 2007; Mann et al. 1983).

Picloram, another synthetic auxin herbicide, has been shown to be very effective in controlling ironweed. Peters and Lowance (1979) judged control based on one year after treatment shoot density reduction. They reported reductions as high as 100% under ideal growing conditions when tall ironweed was treated with picloram at 1.12 kg/ha. Lower rates of 0.28 kg/ha and 0.56 kg/ha gave 96% and 99% control, respectively, under ideal growing conditions. However, during a drought period year, control with all products in the test was reduced. Control with picloram was reduced to 80 to 90% with the two lower rates. The highest rate still provided 99% control or better (Peters and Lowance 1979).

Picloram plus 2,4-D was reported to provide greater than 80% visual control two months after treatment when 20 centimeter tall ironweed plants were treated in May (Bradley and Kallenbach 2005). Grazon P+D at 2 pt/ac (0.2 kg picloram per ha and 0.6 kg 2,4-D per ha) reportedly provides greater than 87% control of tall ironweed (Fryman and Witt 2007).

Triclopyr, yet another synthetic auxin herbicide, was shown by Mann et al. (1983) to provide control of tall ironweed when applied in July, when the plants were between 1 and 2 m tall and had just begun to bud. Triclopyr amine at 1.8 kg/ha provided greater than 95 % visual control 10 weeks after treatment (WAT) with only 10% regrowth 45 WAT. Similarly, triclopyr ester at 1.6 kg/ha provided 98% visual control and 13% regrowth. Addition of 2,4-D ester to triclopyr amine did not improve 10 week visual control, and caused more regrowth 45 WAT. (Mann et al. 1983).

Marshall et al. (2006) applied triclopyr products in the early fall to tall ironweed that had been mowed and then allowed to regrow for 4 or 5 weeks. Treatments containing 0.47 to 0.63 kg/ha of triclopyr provided 93 to 99% control eight months after treatment (MAT). One year later, those treatments still provided suppression of tall ironweed. All products containing triclopyr also significantly reduced shoot densities one year after treatment (YAT) (Marshall et al. 2006).

Dicamba, another synthetic auxin herbicide, has also provided some control of tall ironweed. When applied in early fall at 1.12 kg/ha, dicamba provided 87% control 8 MAT. However, by 1 YAT, the dicamba control had decreased to less than 60%. Also, plots treated with dicamba reported increased shoot densities 1 YAT (Marshall et al. 2006). Fryman and Witt (2007) reported less than 75% control 1 YAT with dicamba at 0.6 kg/ha and a dicamba plus 2,4-D product at 0.3 and 0.8 kg/ha, respectively. Bradley and Kallenbach (2005), though, reported

greater than 80% control of 20 centimeter tall ironweed when treated in May with 2,4-D plus dicamba.

Aminopyralid, another auxin herbicide, has also been evaluated for control of tall ironweed. At 70 to 88 g/ha, aminopyralid provided 83 to 86% control of tall ironweed. Aminopyralid mixed with 2,4-D at up to 138.6 g/ha and 1.1 kg/ha, respectively, provided up to 89% control of tall ironweed (Fryman and Witt 2007).

Several products were evaluated for their efficacy on tall ironweed when applied with a rope wick-type applicator. When the applicator was passed over the plots at 2 mph carrying aminopyralid solutions of 1, 10, and 20% of the formulation by volume, control of tall ironweed ranged from 88 to 96%. When applied with the rope wick-type applicator at 2 mph, glyphosate provided 91% control of tall ironweed when the solution was 50% by volume. Triclopyr provided 86% control of tall ironweed when applied in a 20% solution, and clopyralid provided 88% control of tall ironweed with a 20% solution, both using the wick applicator at 2 mph. (Fryman and Witt 2007).

The new synthetic auxin herbicide aminocyclopyrachlor has been reported to have action on tall ironweed. The rate of 1.5 oz ai/ac, a higher rate than required to control most weeds with aminocyclopyrachlor, provided excellent control of tall ironweed (Rhodes 2010).

Aminocyclopyrachlor

Aminocyclopyrachlor is a synthetic auxin herbicide, belonging to the pyrimidine carboxylic acid family, discovered by DuPont Crop Protection. Its chemical name is 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid. Its CAS registry number is 858956-08-8. DuPont's current designation for the acid form of aminocyclopyrachlor is DPX-MAT28 (Finkelstein et al. 2008).

Like other synthetic auxin herbicides, aminocyclopyrachlor has activity on many broadleaf species with little effect on most grasses. Its proposed uses include controlling broadleaf weeds in bareground, brush, roadside, pasture, and rangeland. Proposed use rates range from 0.25 to 4.5 oz ai/ac. The manufacturer reports that it provides good control of many weed species including dandelion (*Taraxacum officinale* G.H. Weber in Wiggers), tall ironweed (*Vernonia gigantea* (Walt.) Trel.), ragweeds (*Ambrosia* sp.), plantains (*Plantago* sp.), thistles (*Cirsium* sp.; *Carduus* sp.), honeysuckle (*Lonicera japonica* Thunb.), poison ivy (*Toxicodendron radicans* (L.) Kuntze), and sumac (*Rhus* sp.), to name a few (Finkelstein et al. 2008).

Aminocyclopyrachlor is readily absorbed by plant leaves and roots, and it is translocated in both the xylem and phloem. The molecule accumulates in meristematic regions of the plant and impacts plant hormonal balance required for shoot and root growth. Selectivity is similar to that seen with other synthetic auxin herbicides. Aminocyclopyrachlor is readily broken down in the environment by soil microbes and/or is photodegraded, with reported half-lives ranging from 37 days in turf studies to 128 days in bareground studies. Also, it appears to have a favorable mammalian toxicity profile (Finkelstein et al. 2008).

CHAPTER III

Utility of Aminocyclopyrachlor for Control of Horsenettle and Tall Ironweed in Cool-season Grass Pastures.

Introduction

Management of some perennial pasture weeds has been very difficult or impossible with traditional pasture herbicides, clipping, or grazing due to their tolerance of high levels of many herbicides, their capacity to store ample carbohydrates in rhizomes and roots, and the fact that most grazing animals avoid them. This can lead to buildup of these weeds in pastures and hayfields that are otherwise weed free and being managed properly. Two such troublesome weeds in Tennessee pastures and hayfields are horsenettle (*Solanum carolinense* L.) and tall ironweed (*Vernonia gigantea* (Walt.) Trel.). This research was conducted to identify the optimum rate and application timing of the new herbicide aminocyclopyrachlor for control of horsenettle and tall ironweed in cool-season grass pastures and to compare its efficacy with that of aminopyralid.

Materials and Methods

Research was conducted on naturally-occurring infestations of horsenettle and tall ironweed in tall fescue pastures. Horsenettle studies were conducted in 2010 at Alcoa, Fork Creek, and Greenback, Tennessee. The studies were repeated in 2011 at Maynardville, Tennessee, and at Fork Creek, on an adjacent, previously untreated area. Tall ironweed studies were conducted at Pulaski, Tennessee, and London, Kentucky, in 2010. These studies were also repeated in 2011 at both locations on adjacent, previously untreated areas.

A randomized complete block design with four replications was utilized in all studies. Blocking was based on field parameters to minimize errors due to changes in weed population

across the site. Experimental units were 4.6 m wide by 9.1 m long, with the center 3 m being treated. Treatments were applied using a CO₂ backpack sprayer and a six-nozzle boom calibrated to deliver 15 L/ha of spray solution. Two untreated control plots were included in each replication. Every herbicide treatment was applied with a non-ionic surfactant¹ at 0.25% v/v.

There were five herbicide treatments and two application timings (early post-emergent and late post-emergent, hereafter referred to as EPOST and LPOST) in the tall ironweed trials. The same five herbicide treatments were used in the horsenettle trials, which included early, mid, and late post-emergent (EPOST, MPOST, and LPOST) application timings. The treatments, which are listed in Tables 3.1 and 3.2, included two rates of aminocyclopyrachlor² alone, two rates of aminocyclopyrachlor plus 2,4-D³, and aminopyralid⁴. The dates of the various treatments are shown in Table 3.3. The rainfall and temperature data for the research locations is shown in Tables 3.4 - 3.7.

Efficacy of treatments was measured utilizing visual estimates of weed control, weed stem counts, and fresh and dry weights of weed biomass. Visual estimates of weed control were conducted at 2, 4, 6, 10, 14, and 18 weeks after treatment (WAT), or until a killing frost. Visual evaluations for all treatments were also taken one year after the EPOST timing. All visual evaluations were based on a 0 to 100 percent weed control scale when compared to the untreated checks, with 0 being no control and 100 being complete control. (Tall fescue injury ratings were conducted at these timings as well, but no fescue injury was seen with these treatments.) Weed stem counts, average heights, and biomass were determined for a one square meter area in each plot at the end of the growing season of the year they were treated. Weed stem counts, average heights, and biomass were also measured one year after the EPOST timing. The sample area was

determined by randomly tossing a one square meter PVC square into each plot. Fresh biomass samples were weighed in the field; samples were then placed in a 54° C drying oven for 30 hours, after which they were weighed again for dry weight biomass.

The data were analyzed for each application timing using ANOVA in SAS⁵. Additionally, the season-end and year-after visual evaluations, stem counts, heights, and biomass were analyzed across application timings using ANOVA in SAS. Means from the above analyses were separated using Student-Newman-Keul's comparison. Data were not pooled across location, as there was a significant location by application timing interaction due to wide differences in soil type, rainfall, and temperature across locations.

Results and Discussion

Horsenettle

Alcoa 2010

Visual control estimates taken 2 WAT for the EPOST application showed horsenettle control ranging from 56% for aminocyclopyrachlor at the low rate alone to 79% for aminopyralid (Table 3.8), with significant differences among treatments. By 4 WAT, however, there were no differences among treatments; control ranged from 82 to 93%. At 6 WAT, all treatments provided $\geq 90\%$ control. The level of control for all treatments did not decrease as the season progressed.

When visual control evaluations were taken 2 WAT for the MPOST application, control was approximately 80% for all treatments (Table 3.9). By 4 WAT, control of horsenettle with all MPOST treatments was $>90\%$, with no statistical differences between treatments. Visual control did not decrease for the remainder of the growing season.

The LPOST treatments (applied to horsenettle plants setting fruit) provided much lower visual control from 2 WAT to the end of the growing season (Table 3.10). When those treatments were applied, available soil moisture at this location was low (Table 3.4). At 4 WAT, Control ranged from 43 to 81%, with aminocyclopyrachlor plus 2,4-D at the high rate providing significantly better control than aminocyclopyrachlor at the low rate alone.

The weed density and weed biomass data taken in October of 2010, the year of application, failed to show significant differences among treatments (Table 3.11). Numerically, untreated checks and all LPOST treatments had higher values for density, height, and biomass than treatments applied EPOST or MPOST. What was observed in the field may explain this, and may also partially explain why values for all LPOST treatments were similar to those in the untreated checks. By the time the LPOST application was applied in September, the horsenettle plants had completed their vegetative growth stage and were setting fruit. While many of the LPOST treatments severely injured or killed the horsenettle prior to the collection of the density, height, and biomass data, the injured or dead plant material was still in the plots, and was measured. The plots to which applications had been made EPOST or MPOST were mainly devoid of horsenettle plant material, living or dead. No attempt was made in the collection of this data to separate healthy, injured, and dead biomass.

When visual evaluations were taken approximately one year after the EPOST treatments here, clear differences among treatments were not found (Table 3.12). No treatment resulted in control >46%. Treatment effects were not significant ($P=.05$) for horsenettle densities, heights, or biomass measurements taken 1 YAT.

Fork Creek 2010

Early evaluations 2 weeks after the EPOST application at Fork Creek revealed visual control means ranging from 61 to 88% (Table 3.13). All treatments provided significantly higher control than the low rate of aminocyclopyrachlor alone, which provided 61% control of horsenettle. By 4 WAT, that control had increased to 86%, and all other treatments provided control $\geq 91\%$, with the high rate of aminocyclopyrachlor (alone or with 2,4-D) and aminopyralid providing greatest control. By 6 WAT, all treatments were controlling horsenettle $\geq 96\%$ control, and control did not decrease significantly for the remainder of the season.

Visual control evaluations 2 WAT for the MPOST treatments were slightly less, with aminopyralid providing 73% control, and all other treatments providing 56 to 61% control (Table 3.14). By 4 WAT, aminopyralid provided greater control of horsenettle than the aminocyclopyrachlor treatments without 2,4-D. There were no differences among the aminocyclopyrachlor treatments; control ranged from 87 to 92%. At 6 WAT, there were no differences among treatments, all of which had control $\geq 93\%$. At the end of the growing season (12 WAT), all treatments still provided horsenettle control $>95\%$.

Visual control evaluations 2 and 4 weeks after the LPOST application were similar to those observed at Alcoa. The only noticeable difference was in the 4 WAT ratings (Table 3.15). At Fork Creek, control was greater 4 weeks after the LPOST timing, which may have been due to the fact that soil moisture was higher at Fork Creek in the late summer. There were no differences among treatments, and control ranged from 76 to 88%.

Analysis of the weed density, height, and biomass data from October 2010 revealed significant differences due to treatments (Table 3.16). All aminocyclopyrachlor treatments applied LPOST had the greatest weed densities, ranging from 2.3 to 3.5 stems/m², and were not statistically different from the untreated check. All other treatments, including aminopyralid

applied LPOST, had horsenettle stem densities which were either 0 or statistically no different than 0. In the average horsenettle height data, only aminocyclopyrachlor at the low rate was statistically different than the other treatments. The mean for this treatment was 28.7 cm, and was not significantly different than the untreated check. There were no significant differences between treatments for either fresh or dry horsenettle biomass. The situation at Fork Creek was quite similar to that at Alcoa in that the horsenettle had completed most of its vegetative growth prior to the LPOST application, and the physical data taken in those plots included many dead or injured stems.

Data collected just over 1 year after the EPOST timing revealed few statistical differences between treatments in visual weed control (Table 3.17). Aminopyralid applied LPOST resulted in 44% control and was statistically lower than all other treatments. Horsenettle control from the EPOST treatments ranged from 63 to 68%, with no differences among treatments. Control for the MPOST treatments ranged from 66 to 80%, with no differences among treatments. Weed control for the aminocyclopyrachlor treatments applied LPOST was between 72 and 81%. All treatments were found to be significantly different than the untreated checks in weed density and biomass, but differences were not found among treatments.

Greenback 2010

An interesting difference was noted in the visual evaluations for the EPOST application at Greenback. Two WAT, control ranged from 66 to 79% for all treatments, with no significant differences (Table 3.18); this was not unlike what was observed at the other 2010 horsenettle locations. Control increased steadily until 6 WAT, at which point all treatments were providing >90% control, and the high rate of aminocyclopyrachlor (with and without 2,4-D) and aminopyralid were providing the greatest control (97-98%). However, after this date, horsenettle

control decreased slightly for the remainder of the season. These lower visual control evaluations were due to flushes of new horsenettle plants in the plots, some of which were able to tolerate the residual effects of the treatments. However, by the end of the season, all treatments were still providing >80% control.

A similar trend was observed in the visual evaluations taken following the MPOST application. Treatments were providing from 71-81% control of horsenettle 2 WAT (Table 3.19). By 6 WAT, control ranged from 84-91%, with no significant differences between treatments. Between this date and the end of the growing season (14 WAT), horsenettle control for all treatments except aminopyralid decreased. Aminopyralid and both rates of aminocyclopyrachlor + 2,4-D provided 84 to 91% control of horsenettle.

At this location in 2010, soil moisture in the late summer was very low (Table 3.4). The horsenettle control observed following the LPOST application was likewise low (Table 3.20). By 4 WAT, only aminopyralid and the high rate of aminocyclopyrachlor were providing >70% control. A lower level of control was also observed at Alcoa after the LPOST application (Table 3.10); late summer precipitation and soil moisture were similar at these two sites.

Clear significant differences were found neither between treatments nor between application timings for the density, height, and biomass data taken at Greenback at the end of the 2010 growing season (Table 3.21). Only in the aminocyclopyrachlor treatments applied EPOST were the density means significantly different from the untreated checks (and statistically equal to 0). All other treatments resulted in densities equal to the untreated checks. A very similar trend was observed in the average weed height data. There were no significant differences between treatments for biomass data.

When visual weed control evaluations were taken 1 year after the EPOST timing, treatments applied EPOST had means from 50-64%, with no differences among treatments (Table 3.22). Means for treatments applied MPOST ranged from 23-58%, with no differences among treatments. Means for treatments applied LPOST ranged from 56-77%, with all aminocyclopyrachlor treatments except the low rate alone providing >70% weed control. This pattern of fair control for EPOST treatments, poor control for MPOST treatments, and fair-good control for LPOST treatments is quite different from what was observed at Alcoa and Fork Creek in 2010. This was likely due to severe drought stress on the horsenettle in July 2010, when MPOST treatments were applied. It is worth noting that there was not as large a difference between MPOST and LPOST means of aminopyralid treatments as was seen in the aminocyclopyrachlor treatments.

While all treatment means for density, height, and biomass taken 1 year after the EPOST timing were found to not differ from the untreated check, numerically, they follow the same pattern as the 1 YAT visual ratings (Table 3.22). Overall, aminocyclopyrachlor at the high rate applied EPOST or LPOST resulted in the lowest horsenettle densities, heights, and biomass.

Fork Creek 2011

In 2011, horsenettle control here was initially lower than in 2010. All treatments applied EPOST provided greater control 2 WAT (ranging from 63 to 78%) than the low rate of aminocyclopyrachlor alone, which provided 49% control (Table 3.23). By 6 WAT, the high rate of aminocyclopyrachlor with 2,4-D and aminopyralid were providing the greatest control of horsenettle (91 to 95%), while both treatments containing the low rate of aminocyclopyrachlor were providing 76 to 80% control. Weed control continued to increase for all treatments through

the end of season, at which point all treatments resulted in >96% control and there were no statistical differences.

Visual control 4 weeks after MPOST treatments ranged from 66 to 84%, with the high rate of aminocyclopyrachlor with 2,4-D and aminopyralid being statistically higher than the other treatments (81 to 84%) (Table 3.24). Control increased slowly through the rest of the growing season, with horsenettle control ranging from 94 to 98% and no significant differences among treatments after 14 weeks.

As the summer progressed, a localized drought resulted in low available soil moisture at Fork Creek. This may have had some bearing on the LPOST timing results (Table 3.25). At 2 WAT, horsenettle control was 31 to 44%. By 4 WAT, control had increased to 68 to 84%, with both aminocyclopyrachlor/2,4-D combinations and aminopyralid being significantly higher than the low rate of aminocyclopyrachlor alone. At 6 WAT, all treatments were providing greater control than the low rate of aminocyclopyrachlor alone.

In October, visual evaluations did not differ significantly among all treatments applied either EPOST or MPOST (Table 3.26). These treatments were providing >92% control. Treatments applied LPOST resulted in control ranging from 68 to 84%. Means for the LPOST treatments were found to be statistically lower than means from treatments in the other two timings.

When end of season horsenettle densities were evaluated, plots receiving EPOST treatments and aminocyclopyrachlor with 2,4-D in the MPOST timing had no horsenettle present, and had means significantly lower than the untreated checks (Table 3.26). A similar pattern was seen when height data were analyzed. Analysis of the dried horsenettle biomass failed to find significant differences among treatments, but differences were found in the fresh

biomass analysis. All EPOST treatments and aminopyralid and the high rate of aminocyclopyrachlor with 2,4-D applied MPOST were found to produce weights significantly lower than the untreated checks.

Maynardville 2011

Visual weed control here was greater 2 WAT for the EPOST treatments than at Fork Creek (Table 3.27). Means ranged from 66 to 85%, with aminocyclopyrachlor at the high rate and aminopyralid providing greatest horsenettle control (78 to 85%). By 6 WAT, all treatments were providing $\geq 87\%$ control, with aminopyralid and the high rate of aminocyclopyrachlor with 2,4-D being significantly higher than the other treatments. By 10 WAT, all treatments were providing $>96\%$ control, with no differences among treatments. Control did not decrease through the remainder of the season.

Four weeks after the MPOST treatments were applied, aminopyralid and aminocyclopyrachlor at the high rate provided the most weed control (87 to 94%) (Table 3.28). By 10 WAT, all treatments were providing $>96\%$ control, with no differences among treatments. Control stayed at this level through the end of the season.

Visual control evaluations 2 WAT for the LPOST treatments revealed notably lower control (Table 3.29). Means ranged from 58 to 68%, with no differences among treatments. Horsenettle control increased through the remainder of the season. At 6 WAT, the last evaluation date before a killing frost, treatments were providing 84 to 89% control.

When visual evaluations taken at the end of the growing season were analyzed across all timings, treatments applied EPOST or MPOST had means that were $>97\%$, and were significantly higher than all treatments applied LPOST (Table 3.30). Clear significant differences were not found in the horsenettle density or height data. All EPOST treatments and

most MPOST treatments had means of 0. The LPOST treatments had means that were higher than the untreated check means for density and height. A very similar pattern is present in the fresh and dry horsenettle biomass data. Most treatments applied EPOST or MPOST had means of 0. Like in the density and height data, LPOST treatments had means which were numerically, but not statistically, higher than the untreated checks.

Tall Ironweed

London 2010

When visual control evaluations were taken 2 WAT for the EPOST treatments applied to tall ironweed, control ranged from 75 to 85%, with no differences among treatments (Table 3.31). Control increased steadily until 6 WAT, at which time all treatments had $\geq 89\%$ control of tall ironweed. The level of control did not significantly decrease through the end of the growing season.

Initially, visual control evaluations taken after the LPOST application indicated less tall ironweed control (49 to 66%), with no significant treatment differences 2 WAT (Table 3.32). By 6 WAT, though, all aminocyclopyrachlor treatments provided control between 88 and 96%. Level of tall ironweed control for the aminopyralid treatment was significantly lower, at 80%.

When physical data was collected at the end of the 2010 growing season, analyzed results followed a pattern similar to that seen in the horsenettle studies. Few differences were found in tall ironweed density (Table 3.33). All treatments applied LPOST resulted in plants which were no different in height than the untreated check. Three of the aminocyclopyrachlor treatments and aminopyralid applied EPOST resulted in significantly shorter average tall ironweed heights.

Analysis of fresh and dry weed biomass samples did not reveal significant differences among treatments or application timings.

Visual assessments taken 1 YAT for the EPOST treatments revealed some significant differences among treatments and timings (Table 3.34). All EPOST aminocyclopyrachlor treatments were providing >90% control. Ironweed control provided by aminopyralid in the EPOST timing was significantly less, at 77%. All LPOST treatments were providing $\geq 96\%$ visual control of tall ironweed. Evaluation of stem densities taken 1 YAT revealed all treatments to have ironweed densities that were significantly lower than the untreated checks and statistically equal to 0. All treatments except the low rate of aminocyclopyrachlor with 2,4-D EPOST and aminopyralid EPOST significantly reduced tall ironweed heights compared to the untreated checks. When fresh and dried ironweed biomass samples were analyzed, all treatments resulted in weights which were significantly lower than the samples from the untreated plots. Significant differences among treatments or timings were not found.

Pulaski 2010

At Pulaski, where conditions were both hotter and drier than London in 2010 (Table 3.5), control of tall ironweed with all treatments applied EPOST was excellent (Table 3.35). Visual control evaluations taken 2 WAT showed treatments providing 79 to 86% control, with no statistical differences among treatments. By 4 WAT, all treatments provided tall ironweed control $\geq 96\%$. Tall ironweed control remained above 96% for all treatments through the end of the growing season.

Overall, treatments applied LPOST to flowering tall ironweed provided less control than the same treatments at London (Table 3.36). Visual control means 2 WAT for the LPOST timing ranged from 48 to 58%. By 6 WAT, the last evaluation date before a killing frost, tall

ironweed control ranged from 78 to 88%. Significant differences were not found among treatments on either date.

As with the other locations, physical data collected at the end of the growing season in which treatments were applied failed to show many treatment means that were significantly different than the untreated checks (Table 3.37). Analysis of tall ironweed density, average height, and fresh weight did not reveal any treatments to be statistically different from the checks. However, when the data taken from the dried ironweed samples was analyzed, all EPOST treatments plus aminopyralid LPOST were found to have weights statistically lower than the untreated check, and no different than 0.

When visual control evaluations were taken one year after the EPOST application, significant differences among treatments, but not application timings, were found (Table 3.38). Aminopyralid applied at either timing was providing the least control (82% in the EPOST timing and 74% in the LPOST timing). All treatments resulted in ironweed densities that were statistically less than the untreated checks and statistically equal to 0. The average ironweed height data follows a very similar pattern. Analysis of fresh and dried biomass samples failed to show significant differences among treatments; however, all treatments were significantly different from the checks and statistically equal to 0.

London 2011

EPOST treatments provided excellent tall ironweed control in 2011 (Table 3.39). At 2 WAT, visual tall ironweed control was 85 to 88% for all treatments. By 6 WAT, all treatments were providing $\geq 97\%$ control. Control did not decrease through the end of the season (16 WAT), at which time all treatments were providing $>97\%$ control, and there were no statistical differences among treatments.

Visual control evaluations taken 2 WAT for the LPOST application applied to flowering tall ironweed indicated lower initial control (45 to 63%) with no differences among treatments (Table 3.40). Tall ironweed control increased throughout the rest of the season, with treatments providing 73 to 85% control 6 WAT, the last date evaluations were taken before a killing frost. No significant differences among treatments were found.

Visual evaluations of treatments in both timings at the end of the season were analyzed, and all treatments applied EPOST to vegetative ironweed were providing significantly greater control than treatments applied LPOST to flowering ironweed (Table 3.41). When tall ironweed density was measured at this time, all EPOST treatments had means of 0, and all LPOST treatments had means which lower than the untreated checks and statistically equal to 0. In height data, all EPOST treatments had means of 0, and aminopyralid was the only LPOST treatment which had a mean that was significantly different from the untreated checks. When fresh and dry ironweed biomass was analyzed, all treatments were found to have significantly lower weights than the untreated checks, with no differences among treatments or timings. All EPOST treatments had means of 0, and all LPOST treatments had means higher than but statistically equal to 0 and below the values of the untreated check means.

Maynardville 2011

Since there was a widespread, uniform population of tall ironweed in the horsenettle trial at Maynardville, tall ironweed control was rated after each of the three application timings. The first and last timing corresponded with the EPOST and LPOST timings in the other ironweed trials. When the middle application timing, referred to as MPOST, was applied on 7/15/11, horsenettle were flowering, and the ironweed was in a vegetative growth stage, approximately 46 cm tall.

At 2 WAT for the EPOST treatments, visual tall ironweed control ranged from 77 to 84% (Table 3.42). By 6 WAT, tall ironweed control for all treatments was >98%. Visual control did not decrease throughout the remainder of the season.

Visual evaluations conducted 4 WAT for the MPOST application ranged from 87 to 94%, with no differences among treatments (Table 3.43). By 8 WAT, ironweed control was 99% for all treatments. This level of control did not significantly decrease through the end of the season.

Ironweed control 2 weeks after the LPOST application was slightly lower, 69 to 75%, with no significant differences among treatments (Table 3.44). By 6 WAT, the last evaluation taken before a killing frost, control had risen to 85 to 94%. No significant differences were found among treatments.

Visual evaluations taken at the end of the season were analyzed across all application timings, and revealed no differences among treatments applied EPOST or MPOST (Table 3.45). These treatments had means >98%. Treatments applied LPOST provided significantly lower control (82 to 89%). Analysis of the ironweed density data revealed all treatments had densities that were either 0 or statistically equal to 0. Clear significant differences were not found when average height data were analyzed. When the fresh weed biomass data were analyzed, all treatments applied EPOST or MPOST plus the high rate of aminocyclopyrachlor with 2,4-D LPOST were found to have ironweed weights that were significantly lower than those of the untreated checks, and statistically equal to zero. Numerically, this is also seen in the analysis of the dry ironweed weights, but the differences were no longer statistically significant.

Pulaski 2011

Tall ironweed control for all EPOST treatments here was lower than the same treatments in 2010 (Table 3.46). At 2 WAT, control ranged from 71 to 84%, with the aminocyclopyrachlor

with 2,4-D treatments providing significantly higher control than aminopyralid. By 6 WAT, visual control of tall ironweed for aminocyclopyrachlor treatments was >89%; aminopyralid was providing 74% control. Weed control continued to increase, and all aminocyclopyrachlor treatments had means significantly higher than aminopyralid means through the end of the growing season.

Treatments applied LPOST responded more similarly to their respective 2010 treatments (Table 3.47). At 2 WAT, visual control means were 50 to 60%, with no significant differences among treatments. By the end of the growing season (6 WAT), tall ironweed control had increased to 70 to 81%, with no significant differences among treatments.

When tall ironweed control was analyzed across both timings at the end of the growing season, treatments applied EPOST were providing the greatest control (Table 3.48). The high rate of aminocyclopyrachlor (with and without 2,4-D) applied EPOST provided greater control of tall ironweed than aminopyralid in either timing and aminocyclopyrachlor LPOST. The high rate of aminocyclopyrachlor EPOST also resulted in the lowest ironweed densities and heights, but significant differences were not as clear. Due to a malfunction of the scale in the field, fresh ironweed biomass data is not available. Analysis of the dry biomass data revealed that all EPOST treatments resulted in means that were 0 or statistically equal to 0. The low rate of aminocyclopyrachlor LPOST had a mean higher than the untreated checks. All other LPOST treatments had means between those of the EPOST treatments and the untreated checks.

Conclusion

Our research suggests that tall ironweed may be effectively controlled (99%) 1 YAT with aminocyclopyrachlor at rates as low as 49 g ai/ha applied LPOST, when ironweed is flowering.

Good control (>95%) may also be attained 1 YAT with an EPOST application, but the higher rate would be recommended for consistent results. The addition of 2,4-D at the rates used in this study did not usually improve efficacy on tall ironweed over aminocyclopyrachlor alone. However, the addition of 2,4-D also did not antagonize aminocyclopyrachlor activity, and increased efficacy on several other weeds (such as *Amaranthus* sp.) which were present in the plots but not included in this study. It is worth noting that while year-after tall ironweed control was greatest with LPOST applications, if same-season control was more important in a certain situation than year-after control, an EPOST application would be recommended.

Applications of aminocyclopyrachlor may also provide fair control (70 to 80%) of horsenettle in the following year. A LPOST application of 98 g ai/ha (with or without 2,4-D) or 49 g ai/ha with 2,4-D would be expected to provide the best control. Horsenettle in this study was not as susceptible to aminocyclopyrachlor as tall ironweed. To achieve horsenettle control similar to that seen with ironweed, higher herbicide rates or repeat applications would likely be necessary. To maximize efficacy, it is important that the horsenettle plants not be drought-stressed at the time of treatment. Similar to what was seen in the ironweed study, while LPOST applications provided the highest year-after control of horsenettle, EPOST applications provided better control in the year of treatment.

The success of a late summer herbicide application for perennial weed control seen in these studies is likely due to several factors. Two factors believed to play an important role in this work are direction of sugar flow and interception of spray droplets. In the late summer, after flowering and fruit set, perennial weeds direct flow of sugars from sources in the leaves to underground overwintering structures, roots and rhizomes. Since synthetic auxin herbicides like aminocyclopyrachlor are phloem mobile, it is more likely that more herbicide molecules will

reach the root and rhizomes if the herbicide is applied to the leaves in late summer or early fall than if the application is made in early summer, when sugars being directed to new leaves and above ground meristems. Also, a plant with larger leaf surface area, more typical of warm-season perennial plants in the late summer rather than the early summer, will intercept more spray droplets when a herbicide application is made, and will therefore intercept more grams of active ingredient.

An evaluation of aminocyclopyrachlor efficacy on these two weeds 2-3 years after treatment was not included in this study, but would be useful in making management decisions concerning the use of this new active ingredient in pastures and hayfields.

Sources of Materials

¹Induce surfactant, Helena Chemical Company, 225 Schilling Boulevard, Suite 300, Collierville, TN 38017

²DPX-MAT28, E. I. du Pont de Nemours and Company, Crop Protection, 1007 Market Street, Wilmington, DE 19898.

³2,4-D Amine, E. I. du Pont de Nemours and Company, Crop Protection, 1007 Market Street, Wilmington, DE 19898.

⁴Milestone, Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268.

⁵SAS 9.2, SAS Institute Inc., SAS Circle, Box 8000, Cary, NC 27512-8000.

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APPENDIX

Table 3.1
Horsenettle Treatments

Herbicide	Timing	Rate (g ai/ha)	Plant Stage
Untreated			
Aminocyclopyrachlor	EPOST	49	Vegetative
Aminocyclopyrachlor	EPOST	98	Vegetative
Aminocyclopyrachlor + 2,4-D	EPOST	49 + 371	Vegetative
Aminocyclopyrachlor + 2,4-D	EPOST	98 + 742	Vegetative
Aminopyralid	EPOST	88	Vegetative
Aminocyclopyrachlor	MPOST	49	Flowering
Aminocyclopyrachlor	MPOST	98	Flowering
Aminocyclopyrachlor + 2,4-D	MPOST	49 + 371	Flowering
Aminocyclopyrachlor + 2,4-D	MPOST	1.4 + 742	Flowering
Aminopyralid	MPOST	88	Flowering
Aminocyclopyrachlor	LPOST	49	Early berry
Aminocyclopyrachlor	LPOST	98	Early berry
Aminocyclopyrachlor + 2,4-D	LPOST	49 + 371	Early berry
Aminocyclopyrachlor + 2,4-D	LPOST	98 + 742	Early berry
Aminopyralid	LPOST	88	Early berry
Untreated			

Table 3.2
Tall Ironweed Treatments

Herbicide	Timing	Rate (g ai/ha)	Plant stage
Untreated			
Aminocyclopyrachlor	EPOST	49	Vegetative
Aminocyclopyrachlor	EPOST	98	Vegetative
Aminocyclopyrachlor + 2,4-D	EPOST	49 + 371	Vegetative
Aminocyclopyrachlor + 2,4-D	EPOST	98 + 742	Vegetative
Aminopyralid	EPOST	88	Vegetative
Aminocyclopyrachlor	LPOST	49	Flowering
Aminocyclopyrachlor	LPOST	98	Flowering
Aminocyclopyrachlor + 2,4-D	LPOST	49 + 371	Flowering
Aminocyclopyrachlor + 2,4-D	LPOST	98 + 742	Flowering
Aminopyralid	LPOST	88	Flowering
Untreated			

Table 3.3 Application Dates of Horsenettle and Tall Ironweed Studies in 2010 and 2011

Target Weed	Location	<u>2010</u>			<u>2011</u>		
		EPOST	MPOST	LPOST	EPOST	MPOST	LPOST
Horsenettle	Alcoa	6/30/10	7/14/10	9/14/10			
	Greenback	6/17/10	7/16/10	9/9/10			
	Fork Creek	6/3/10	7/15/10	9/9/10	5/31/11	7/8/11	9/8/11
	Maynardville				6/29/11	7/15/11	9/9/11
Tall Ironweed	London	6/15/10	NA	8/23/10	6/20/11	NA	8/30/11
	Pulaski	6/7/10	NA	8/25/10	5/25/11	NA	8/31/11

Table 3.4	Weather Data for Knoxville, TN*	May-September 2010 & 2011	
Month	Precipitation (cm)	Departure from Avg.	Mean Temperature(°C)
May 2010	10.7	-1.2	21.6
June 2010	3.2	-7.1	26.6
July 2010	15.0	3.0	27.7
August 2010	7.1	-0.2	27.4
September 2010	11.0	3.3	22.9
May 2011	4.2	-7.7	20.0
June 2011	7.6	-2.7	25.6
July 2011	6.3	-5.6	27.7
August 2011	2.7	-5.6	26.7
September 2011	22.2	14.0	21.1

*Knoxville, TN is the closest NWS Recording Station to Alcoa, Fork Creek, and Greenback, TN.

Table 3.5	Weather Data for Huntsville, AL*	May-September 2010 & 2011	
Month	Precipitation (cm)	Departure from Avg.	Mean Temperature(°C)
May 2010	12.4	-0.0	22.9
June 2010	7.0	-3.7	27.8
July 2010	5.1	-6.1	28.7
August 2010	8.8	0.4	29.3
September 2010	6.4	-4.5	24.5
May 2011	4.9	-8.5	21.2
June 2011	9.5	-1.2	27.2
July 2011	8.4	-2.8	27.9
August 2011	9.7	0.5	27.1
September 2011	15.5	6.1	21.1

*Huntsville, AL is the closest NWS Recording Station to Pulaski, TN.

Table 3.6	Weather Data for London, KY	May-September 2010 & 2011	
Month	Precipitation (cm)	Departure from Avg.	Mean Temperature(°C)
May 2010	13.9	2.0	19.3
June 2010	9.8	-1.0	24.8
July 2010	11.7	0.5	25.2
August 2010	15.3	6.8	25.2
September 2010	7.1	-1.5	20.3
May 2011	14.1	2.2	17.8
June 2011	16.3	5.6	22.9
July 2011	10.2	-1.0	25.5
August 2011	7.8	-1.6	23.9
September 2011	12.5	3.9	18.8

Table 3.7	Weather Data for Tazewell, TN*	May-September 2011	
Month	Precipitation (cm)	Departure from Avg.	Mean Temperature(°C)
May 2011	8.2	-5.2	17.8
June 2011	24.6	14.0	22.8
July 2011	12.8	1.2	25.2
August 2011	7.6	-2.2	23.5
September 2011	26.3	18.1	19.4

*Tazewell, TN is the closest NWS Recording Station to Maynardville, TN.

Table 3.8 Utility of Aminocyclopyrachlor for Control of Horsenettle, Alcoa, TN 2010, EPOST Timing

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)				
		Timing WAT				
		2	4	6	10	14
Aminocyclopyrachlor	49	56 c	85 a	90 a	99 a	99 a
Aminocyclopyrachlor	98	63 bc	82 a	90 a	98 a	98 a
Aminocyclopyrachlor + 2,4-D	49 + 371	64 bc	83 a	95 a	99 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	74 ab	88 a	98 a	99 a	99 a
Aminopyralid	88	79 a	93 a	98 a	99 a	99 a
Untreated Check		0 d	0 b	0 b	0 b	0 b
LSD (0.05)		10	9	6	1	1

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.9 Utility of Aminocyclopyrachlor for Control of Horsenettle, Alcoa, TN 2010, MPOST Timing

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)				
		Timing WAT				
		2	4	6	10	12
Aminocyclopyrachlor	49	80 a	93 a	99 a	99	99
Aminocyclopyrachlor	98	78 a	92 a	96 a	99	99
Aminocyclopyrachlor + 2,4-D	49 + 371	81 a	92 a	99 a	99	99
Aminocyclopyrachlor + 2,4-D	98 + 742	84 a	96 a	99 a	99	99
Aminopyralid	88	81 a	97 a	98 a	99	99
Untreated Check		0 b	0 b	0 b	0	0
LSD (0.05)		8	6	3	**	**

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

**No variance between replications within treatments. Means separation unnecessary.

Table 3.10 Utility of Aminocyclopyrachlor for Control of Horsenettle, Alcoa, TN 2010, LPOST Timing

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)	
		Timing WAT	
		2	4
Aminocyclopyrachlor	49	60 b	43 b
Aminocyclopyrachlor	98	60 b	57 ab
Aminocyclopyrachlor + 2,4-D	49 + 371	66 ab	60 ab
Aminocyclopyrachlor + 2,4-D	98 + 742	71 ab	81 a
Aminopyralid	88	75 a	73 ab
Untreated Check		0 c	0 c
LSD (0.05)		9	27

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.11 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, End of Season
Alcoa, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	5 a	22.4 ab	41.55	17.5
¹ Aminocyclopyrachlor	49	87 ab	0 a	0 b	0	0
¹ Aminocyclopyrachlor	98	96 a	0.3 a	8.9 ab	1.03	0.35
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	94 a	0 a	0 b	0	0
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 a	0 b	0	0
¹ Aminopyralid	88	99 a	0 a	0 b	0	0
² Aminocyclopyrachlor	49	97 a	0 a	0 b	0	0
² Aminocyclopyrachlor	98	99 a	0 a	0 b	0	0
² Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 a	0 b	0	0
² Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 a	0 b	0	0
² Aminopyralid	88	99 a	0 a	0 b	0	0
³ Aminocyclopyrachlor	49	70 ab	5.3 a	24.1 ab	71.5	27.83
³ Aminocyclopyrachlor	98	69 ab	5.5 a	34.3 a	73.08	31.45
³ Aminocyclopyrachlor + 2,4-D	49 + 371	71 ab	3.3 a	22.4 ab	21.85	9.23
³ Aminocyclopyrachlor + 2,4-D	98 + 742	87 ab	1.3 a	15.2 ab	5.1	2.35
³ Aminopyralid	88	64 b	2.5 a	25.4 ab	37.9	11.45
Untreated Check		0 c	3 a	21.1 ab	36.2	15.25
LSD (0.05)		18	4.3	17.6	NS	NS

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.12 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, 1 YAT
Alcoa, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 b	17.5	16	59	18.2
¹ Aminocyclopyrachlor	49	21ab	10.3	10.9	15.3	4.5
¹ Aminocyclopyrachlor	98	24 ab	6.5	14.7	21.3	5.9
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	19 ab	11.5	10.9	17.9	5.3
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	38 ab	5.3	10.9	7.1	2.3
¹ Aminopyralid	88	43 ab	7	10.2	11	3.4
² Aminocyclopyrachlor	49	20 ab	9.8	10.9	12.6	3.4
² Aminocyclopyrachlor	98	25 ab	8	14.7	22.3	6.1
² Aminocyclopyrachlor + 2,4-D	49 + 371	26 ab	10.3	13.5	29.2	7.7
² Aminocyclopyrachlor + 2,4-D	98 + 742	20 ab	4.8	13.5	9.1	3
² Aminopyralid	88	19 ab	14.5	14	26.6	7.7
³ Aminocyclopyrachlor	49	18 ab	11.5	15.2	18.4	4.8
³ Aminocyclopyrachlor	98	46 ab	6.5	14.7	9.8	2.9
³ Aminocyclopyrachlor + 2,4-D	49 + 371	14 ab	5.5	9.7	9.4	2.5
³ Aminocyclopyrachlor + 2,4-D	98 + 742	34 ab	6.3	9.7	10.5	3.1
³ Aminopyralid	88	15 ab	7	7.1	8.8	2.7
Untreated Check		0 b	11.3	13.5	26.8	7.8
LSD (0.05)		24	NS	NS	NS	NS

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.13 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2010, EPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)					
		Timing WAT					
		2	4	6	10	14	18
Aminocyclopyrachlor	49	61 b	86 c	96 b	98 a	94 b	97 a
Aminocyclopyrachlor	98	80 a	94 ab	99 a	99 a	98 a	98 a
Aminocyclopyrachlor + 2,4-D	49 + 371	76 a	91 bc	97 ab	99 a	99 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	84 a	97 ab	99 a	99 a	99 a	99 a
Aminopyralid	88	88 a	99 a	99 a	98 a	97 a	97 a
Untreated Check		0 c	0 d	0 c	0 b	0 c	0 b
LSD (0.05)		9	6	2	2	2	2

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.14 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2010, MPOST

Herbicide Treatments	Rate(g ai/ha)	Horsenettle Control (%)					
		Timing WAT					
		2	4	6	8	10	12
Aminocyclopyrachlor	49	56 b	87 b	93 a	87 b	98 a	96 a
Aminocyclopyrachlor	98	60 b	88 b	94 a	96 a	98 a	98 a
Aminocyclopyrachlor + 2,4-D	49 + 371	59 b	91 ab	96 a	97 a	98 a	96 a
Aminocyclopyrachlor + 2,4-D	98 + 742	61 b	92 ab	95 a	97 a	99 a	99 a
Aminopyralid	88	73 a	95 a	99 a	98 a	99 a	99 a
Untreated Check		0 c	0 c	0 b	0 c	0 b	0 b
LSD (0.05)		9	6	5	3	1	3

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.15 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2010, LPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)	
		Timing WAT	
		2	4
Aminocyclopyrachlor	49	60 a	80 a
Aminocyclopyrachlor	98	65 a	83 a
Aminocyclopyrachlor + 2,4-D	49 + 371	49 b	76 a
Aminocyclopyrachlor + 2,4-D	98 + 742	58 a	80 a
Aminopyralid	88	60 a	88 a
Untreated Check		0 c	0 b
LSD (0.05)		6	9

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.16 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, End of Season
Fork Creek, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 d	4 ab	26.7 abc	27.73 b	12.85 b
¹ Aminocyclopyrachlor	49	97 a	0 c	0 c	0 b	0 b
¹ Aminocyclopyrachlor	98	98 a	0.3 c	2.54 c	0.53 b	0.3 b
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 c	0 c	0 b	0 b
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 c	0 c	0 b	0 b
¹ Aminopyralid	88	97 a	0.3 c	7.1 bc	0.25 b	0.23 b
² Aminocyclopyrachlor	49	96 a	0.8 bc	3.8 c	0.5 b	0.3 b
² Aminocyclopyrachlor	98	98 a	0 c	0 c	0 b	0 b
² Aminocyclopyrachlor + 2,4-D	49 + 371	96 a	0.8 bc	16 abc	3.65 b	1.63 b
² Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 c	0 c	0 b	0 b
² Aminopyralid	88	99 a	0 c	0 c	0 b	0 b
³ Aminocyclopyrachlor	49	80 bc	3.5 abc	28.7 ab	18.83 b	9.78 b
³ Aminocyclopyrachlor	98	83 bc	2.5 abc	19.8 abc	19.83 b	11.33 b
³ Aminocyclopyrachlor + 2,4-D	49 + 371	76 c	2.3 abc	23.6 abc	6.48 b	4.25 b
³ Aminocyclopyrachlor + 2,4-D	98 + 742	80 bc	2.3 abc	24.9 bc	8.33 b	5.03 b
³ Aminopyralid	88	88 b	0.5 c	8.4 bc	3.75 b	1.73 b
Untreated Check		0 d	5 a	38.1 a	77.78 a	46.65 a
LSD (0.05)		6	2.2	15.2	31.2	19.39

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.17 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, 1 YAT
Fork Creek, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	12 a	16	18.11 ab	5.03 ab
¹ Aminocyclopyrachlor	49	63 a	3 a	8.4	4.29 b	1.25 b
¹ Aminocyclopyrachlor	98	68 a	2 a	9.7	2.94 b	0.88 b
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	64 a	4 a	18.5	7.07 b	1.91 b
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	66 a	2.5 a	9.7	2.49 b	0.79 b
¹ Aminopyralid	88	67 a	6.8 a	9.7	11.6 b	3.15 b
² Aminocyclopyrachlor	49	66 a	3.5 a	10.2	2.48 b	0.81 b
² Aminocyclopyrachlor	98	70 a	4 a	17.3	4.78 b	1.48 b
² Aminocyclopyrachlor + 2,4-D	49 + 371	77 a	1.8 a	8.4	1.11 b	0.3 b
² Aminocyclopyrachlor + 2,4-D	98 + 742	80 a	4.3 a	13.5	2.6 b	0.77 b
² Aminopyralid	88	76 a	5.5 a	6.4	5.39 b	1.44 b
³ Aminocyclopyrachlor	49	72 a	2.8 a	12.2	3.63 b	1.04 b
³ Aminocyclopyrachlor	98	80 a	1.8 a	17.3	2.41 b	0.65 b
³ Aminocyclopyrachlor + 2,4-D	49 + 371	80 a	2.8 a	6.4	2.78 b	0.77 b
³ Aminocyclopyrachlor + 2,4-D	98 + 742	81 a	0.8 a	8.4	1.31 b	0.35 b
³ Aminopyralid	88	44 b	5 a	16.5	8.62 b	2.37 b
Untreated Check		0 c	11.8 a	20.3	25.33 a	7.36 a
LSD (0.05)		13	6.5	NS	10.99	2.99

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.18 Utility of Aminocyclopyrachlor for Control of Horsenettle, Greenback, TN 2010, EPOST

Herbicide Treatments	Rate(g ai/ha)	Horsenettle Control (%)					
		Timing WAT					
		2	4	6	10	14	16
Aminocyclopyrachlor	49	66 a	77 a	91 b	88 d	88 a	81 b
Aminocyclopyrachlor	98	79 a	93 a	97 a	97 ab	93 a	93 a
Aminocyclopyrachlor + 2,4-D	49 + 371	70 a	76 a	92 b	94 bc	87 a	87 ab
Aminocyclopyrachlor + 2,4-D	98 + 742	74 a	92 a	98 a	98 a	96 a	94 a
Aminopyralid	88	78 a	85 a	97 a	93 a	89 a	90 ab
Untreated Check		0 b	0 b	0 c	0 c	0 b	0 c
LSD (0.05)		6	15	4	3	7	8

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.19 Utility of Aminocyclopyrachlor for Control of Horsenettle, Greenback, TN 2010, MPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)				
		Timing WAT				
		2	4	6	10	14
Aminocyclopyrachlor	49	76 a	82 a	84 a	76 ab	68 b
Aminocyclopyrachlor	98	71 a	79 a	84 a	71 b	66 b
Aminocyclopyrachlor + 2,4-D	49 + 371	71 a	80 a	87 a	81 ab	85 ab
Aminocyclopyrachlor + 2,4-D	98 + 742	76 a	82 a	89 a	85 ab	84 ab
Aminopyralid	88	81 a	91 a	91 a	92 a	91 a
Untreated Check		0 b	0 b	0 b	0 c	0 c
LSD (0.05)		10	11	8	14	14

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.20 Utility of Aminocyclopyrachlor for Control of Horsenettle, Greenback, TN 2010, LPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)	
		Timing WAT	
		2	4
Aminocyclopyrachlor	49	63 a	55 b
Aminocyclopyrachlor	98	58 a	71 ab
Aminocyclopyrachlor + 2,4-D	49 + 371	58 a	54 b
Aminocyclopyrachlor + 2,4-D	98 + 742	60 a	81 a
Aminopyralid	88	63 a	84 a
Untreated Check		0 b	0 c
LSD (0.05)		9	15

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.21 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, End of Season
Greenback, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 e	11 a	27.9 a	78.28 a	27.3 a
¹ Aminocyclopyrachlor	49	81 abc	1 b	9.7 abc	14.4 a	4.15 a
¹ Aminocyclopyrachlor	98	93 ab	0 b	0 c	0 a	0 a
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	87 abc	0.8 b	4.6 bc	0.6 a	0.2 a
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	94 a	0 b	0 c	0 a	0 a
¹ Aminopyralid	88	90 ab	2.8 ab	5.1 bc	5.88 a	1.8 a
² Aminocyclopyrachlor	49	68 cd	4.8 ab	15.2 abc	25.9 a	7.33 a
² Aminocyclopyrachlor	98	66 cd	3.5 ab	17.3 abc	29.33 a	8.58 a
² Aminocyclopyrachlor + 2,4-D	49 + 371	85 abc	3.3 ab	16.5 abc	29.23 a	8.3 a
² Aminocyclopyrachlor + 2,4-D	98 + 742	84 abc	2.5 ab	12.2 abc	13.83 a	4.08 a
² Aminopyralid	88	91 ab	3 ab	5.8 abc	7.2 a	2.15 a
³ Aminocyclopyrachlor	49	55 d	5.5 ab	19.8 abc	44.75 a	16.8 a
³ Aminocyclopyrachlor	98	71 bcd	6.8 ab	20.3 abc	73.55 a	27.13 a
³ Aminocyclopyrachlor + 2,4-D	49 + 371	54 d	4.5 ab	21.6 abc	41.88 a	13.83 a
³ Aminocyclopyrachlor + 2,4-D	98 + 742	81 abc	5 ab	24.1 ab	25.03 a	9.85 a
³ Aminopyralid	88	84 abc	1.8 ab	16 abc	6.98 a	3.2 a
Untreated Check		0 e	4.3 a	13.5 abc	34.18 a	13.3 a
LSD (0.05)		14	5.4	13	47.39	16.97

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.22 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2010, 1 YAT
Greenback, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 d	15.5 a	17.3 a	52.6 a	14.1 a
¹ Aminocyclopyrachlor	49	51 abc	4 a	17.3 a	17.4 a	4.5 a
¹ Aminocyclopyrachlor	98	64 a	2 a	5.1 a	4.4 a	1.3 a
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	57 ab	5.8 a	12.2 a	9.6 a	2.9 a
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	50 abc	3.3 a	6.4 a	4.8 a	1.6 a
¹ Aminopyralid	88	61 a	4.8 a	10.9 a	7.9 a	4.6 a
² Aminocyclopyrachlor	49	28 bc	5.8 a	13.5 a	17.4 a	5 a
² Aminocyclopyrachlor	98	23 cd	10.8 a	16.5 a	40.2 a	10.8 a
² Aminocyclopyrachlor + 2,4-D	49 + 371	44 abc	14.8 a	9.7 a	43.7 a	11.1 a
² Aminocyclopyrachlor + 2,4-D	98 + 742	51 abc	3.8 a	16.5 a	10.3 a	3 a
² Aminopyralid	88	58 ab	8.8 a	10.9 a	11.3 a	3.5 a
³ Aminocyclopyrachlor	49	56 ab	4.8 a	7.1 a	8.4 a	2.5 a
³ Aminocyclopyrachlor	98	71 a	2.3 a	7.6 a	4.6 a	1.4 a
³ Aminocyclopyrachlor + 2,4-D	49 + 371	73 a	2 a	12.7 a	3.9 a	1.4 a
³ Aminocyclopyrachlor + 2,4-D	98 + 742	77 a	3.5 a	5.1 a	5 a	1.5 a
³ Aminopyralid	88	66 a	3.3 a	7.6 a	8.5 a	2.6 a
Untreated Check		0 d	11.5 a	11.4 a	33.1	8.8 a
LSD (0.05)		20	8.1	8.5	28.8	7.1

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.23 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2011, EPOST

Herbicide Treatments	Rate(g ai/ha)	Horsenettle Control (%)					
		Timing WAT					
		2	4	6	10	14	18
Aminocyclopyrachlor	49	49 b	55 c	76 c	87 b	98 a	99 a
Aminocyclopyrachlor	98	72 a	75 b	88 b	96 a	98 a	99 a
Aminocyclopyrachlor + 2,4-D	49 + 371	63 a	69 b	80 c	95 a	99 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	72 a	73 b	91 ab	99 a	99 a	97 a
Aminopyralid	88	76 a	84 a	95 a	99 a	99 a	99 a
Untreated Check		0 c	0 d	0 d	0 c	0 b	0 b
LSD (0.05)		10	6	5	3	1	3

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.24 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2011, MPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)				
		Timing WAT				
		4	6	10	13	14
Aminocyclopyrachlor	49	66 d	71 bc	82 a	92 a	94 a
Aminocyclopyrachlor	98	76 bc	79 ab	83 a	95 a	97 a
Aminocyclopyrachlor + 2,4-D	49 + 371	72 cd	66 c	81 a	94 a	95 a
Aminocyclopyrachlor + 2,4-D	98 + 742	81 ab	85 a	93 a	97 a	98 a
Aminopyralid	88	84 a	80 ab	93 a	95 a	97 a
Untreated Check		0 e	0 d	0 b	0 b	0 b
LSD (0.05)		6	9	11	7	5

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.25 Utility of Aminocyclopyrachlor for Control of Horsenettle, Fork Creek, TN 2011, LPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	31 b	68 b	66 b
Aminocyclopyrachlor	98	38 ab	76 ab	77 ab
Aminocyclopyrachlor + 2,4-D	49 + 371	38 ab	80 a	78 ab
Aminocyclopyrachlor + 2,4-D	98 + 742	43 a	80 a	85 a
Aminopyralid	88	44 a	84 a	88 a
Untreated Check		0 c	0 c	0 c
LSD (0.05)		6	9	12

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.26 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2011, End of Season
Fork Creek, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/ sq. m	Dry Wt. g/ sq. m
Untreated Check		0 e	4.8 ab	22.9 ab	12.04 ab	4.46 a
¹ Aminocyclopyrachlor	49	99 a	0 d	0 c	0 c	0 a
¹ Aminocyclopyrachlor	98	99 a	0 d	0 c	0 c	0 a
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 d	0 c	0 c	0 a
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	97 a	0 d	0 c	0 c	0 a
¹ Aminopyralid	88	99 a	0 d	0 c	0 c	0 a
² Aminocyclopyrachlor	49	92 ab	1 cd	10.9 abc	3.18 bc	1.37 a
² Aminocyclopyrachlor	98	95 a	1.8 cd	11.4 abc	2 bc	1.18 a
² Aminocyclopyrachlor + 2,4-D	49 + 371	94 ab	1.5 bcd	13.5 abc	1.98 bc	1.12 a
² Aminocyclopyrachlor + 2,4-D	98 + 742	97 a	0 d	0 c	0 c	0 a
² Aminopyralid	88	95 a	0.8 cd	4.6 bc	0.44 c	0.33 a
³ Aminocyclopyrachlor	49	68 d	3 a-d	12.7 abc	7.14 abc	4.62 a
³ Aminocyclopyrachlor	98	76 c	2 a-d	12.2 abc	3.04 bc	1.2 a
³ Aminocyclopyrachlor + 2,4-D	49 + 371	80 c	4 abc	16 abc	11.5 abc	6.19 a
³ Aminocyclopyrachlor + 2,4-D	98 + 742	80 c	1.5 bcd	17.3 abc	4.84 bc	2.36 a
³ Aminopyralid	88	84 bc	2.3 a-d	17.8 abc	4.14 bc	1.8 a
Untreated Check		0 e	5 a	24.1 a	15.87 a	5.54 a
LSD (0.05)		8	2.1	11.6	6.68	3.85

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.27 Utility of Aminocyclopyrachlor for Control of Horsenettle, Maynardville, TN 2011, EPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)				
		Timing WAT				
		2	4	6	10	14
Aminocyclopyrachlor	49	66 b	77 b	88 b	97 a	99 a
Aminocyclopyrachlor	98	78 a	89 a	91 b	97 a	99 a
Aminocyclopyrachlor + 2,4-D	49 + 371	71 b	81 b	87 b	99 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	83 a	91 a	96 a	99 a	99 a
Aminopyralid	88	85 a	92 a	99 a	99 a	99 a
Untreated Check		0 c	0 c	0 c	0 b	0 b
LSD (0.05)		5	5	4	3	1

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.28 Utility of Aminocyclopyrachlor for Control of Horsenettle, Maynardville, TN 2011, MPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)			
		Timing WAT			
		4	8	10	12
Aminocyclopyrachlor	49	82 bc	91 b	98 a	97 a
Aminocyclopyrachlor	98	88 ab	99 a	98 a	99 a
Aminocyclopyrachlor+ 2,4-D	49 + 371	80 c	90 b	96 a	98 a
Aminocyclopyrachlor+ 2,4-D	98 + 742	87 ab	99 a	97 a	98 a
Aminopyralid	88	94 a	99 a	99 a	99 a
Untreated Check		0 d	0 c	0 b	0 b
LSD (0.05)		6	6	3	2

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.29 Utility of Aminocyclopyrachlor for Control of Horsenettle, Maynardville, TN 2011, LPOST

Herbicide Treatments	Rate (g ai/ha)	Horsenettle Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	63 a	82 a	86 a
Aminocyclopyrachlor	98	68 a	84 a	86 a
Aminocyclopyrachlor + 2,4-D	49 + 371	58 a	80 a	84 a
Aminocyclopyrachlor + 2,4-D	98 + 742	58 a	82 a	87 a
Aminopyralid	88	68 a	86 a	89 a
Untreated Check		0 b	0 b	0 b
LSD (0.05)		14	6	5

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.30 Utility of Aminocyclopyrachlor for Control of Horsenettle in 2011, End of Season
Maynardville, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	2 b	12.7 abc	6.7 bc	4.5 b
¹ Aminocyclopyrachlor	49	98 a	0 b	0 c	0 c	0 b
¹ Aminocyclopyrachlor	98	99 a	0 b	0 c	0 c	0 b
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 b	0 c	0 c	0 b
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 b	0 c	0 c	0 b
¹ Aminopyralid	88	99 a	0 b	0 c	0 c	0 b
² Aminocyclopyrachlor	49	97 a	0 b	0 c	0 c	0 b
² Aminocyclopyrachlor	98	99 a	0 b	0 c	0 c	0 b
² Aminocyclopyrachlor + 2,4-D	49 + 371	98 a	0.8 b	5.1 bc	6.2 bc	5.8 b
² Aminocyclopyrachlor + 2,4-D	98 + 742	98 a	0 b	0 c	0 c	0 b
² Aminopyralid	88	99 a	0.3 b	3.8 bc	0.7 c	0.5 b
³ Aminocyclopyrachlor	49	82 b	7.5 a	16 abc	30.9 ab	19.8 ab
³ Aminocyclopyrachlor	98	84 b	7.3 a	27.4 a	39.5 a	27.8 a
³ Aminocyclopyrachlor + 2,4-D	49 + 371	80 b	4.3 ab	24.9 a	26.7 abc	19 ab
³ Aminocyclopyrachlor + 2,4-D	98 + 742	82 b	5 ab	18.5 ab	16.5 abc	16 ab
³ Aminopyralid	88	86 b	5 ab	16 abc	15.9 abc	10.5 ab
Untreated Check		0 c	3.5 ab	14 abc	9.7 bc	6.5 b
LSD (0.05)		4	3.3	9.8	17.2	12.9

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.31 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2010, EPOST

Herbicide Treatments	Rate(g ai/ha)	Tall Ironweed Control (%)					
		Timing WAT					
		2	4	6	10	14	16
Aminocyclopyrachlor	49	79 a	87 bc	91 a	94 a	95 a	96 a
Aminocyclopyrachlor	98	83 a	90 ab	94 a	98 a	98 a	98 a
Aminocyclopyrachlor + 2,4-D	49 + 371	75 a	84 c	91 a	89 a	93 a	92 a
Aminocyclopyrachlor + 2,4-D	98 + 742	85 a	94 a	95 a	99 a	99 a	99 a
Aminopyralid	88	81 a	86 c	89 a	91 a	93 a	92 a
Untreated Check		0 b	0 d	0 b	0 b	0 b	0 b
LSD (0.05)		9	4	6	8	6	7

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.32 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2010, LPOST

Herbicide Treatments	Rate (g ai/ha)	Tall Ironweed Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	49 a	78 bc	90 a
Aminocyclopyrachlor	98	55 a	84 ab	96 a
Aminocyclopyrachlor + 2,4-D	49 + 371	51 a	78 bc	88 a
Aminocyclopyrachlor + 2,4-D	98 + 742	63 a	86 a	96 a
Aminopyralid	88	66 a	74 c	80 b
Untreated Check		0 b	0 d	0 c
LSD (0.05)		19	6	7

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.33 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, End of Season
London, KY

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	8.8 ab	78.2 a	124.78 a	54.9 a
¹ Aminocyclopyrachlor	49	96 a	0.8 b	7.6 b	3.93 a	1.53 a
¹ Aminocyclopyrachlor	98	98 a	0 b	0 b	0 a	0 a
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	92 a	2 b	25.4 ab	15.8 a	5.58 a
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 b	0 b	0 a	0 a
¹ Aminopyralid	88	92 a	0.3 b	5.1 b	0.48 a	0.13 a
² Aminocyclopyrachlor	49	90 a	7.5 ab	66.8 a	64.68 a	33.68 a
² Aminocyclopyrachlor	98	96 a	13.9 a	68.1 a	52.65 a	40.45 a
² Aminocyclopyrachlor + 2,4-D	49 + 371	88 a	5.8 ab	49.5 ab	54.43 a	30.78 a
² Aminocyclopyrachlor + 2,4-D	98 + 742	96 a	9.8 ab	50.8 ab	38.83 a	30.58 a
² Aminopyralid	88	80 b	5 ab	59.7 a	36.1 a	19.7 a
Untreated Check		0 c	8 ab	76.2 a	81.55 a	36.75 a
LSD (0.05)		7	5.9	33.5	74.34	38.03

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Late-postemergent (LPOST)

Table 3.34 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, 1 YAT
London, KY

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 d	17 a	65.5 a	242.5 b	51.3 b
¹ Aminocyclopyrachlor	49	91 ab	1 b	23.6 b	14.3 c	3.5 c
¹ Aminocyclopyrachlor	98	98 a	0 b	0 b	0 c	0 c
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	90 b	3.3 b	40.6 ab	31.5 c	6.8 c
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	97 ab	0 b	0 b	0 c	0 c
¹ Aminopyralid	88	77 c	5 b	38.1 ab	36.5 c	8.3 c
² Aminocyclopyrachlor	49	99 a	0 b	0 b	0 c	0 c
² Aminocyclopyrachlor	98	99 a	0 b	0 b	0 c	0 c
² Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 b	0 b	0 c	0 c
² Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 b	0 b	0 c	0 c
² Aminopyralid	88	99 a	0.3 b	13.5 b	4 c	1 c
Untreated Check		0 d	19.8 a	68.6 a	378 a	74 a
LSD (0.05)		5	3.3	24.9	120.1	20.8

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Late-postemergent (LPOST)

Table 3.35 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2010, EPOST

Herbicide Treatments	Rate(g ai/ha)	Tall Ironweed Control (%)					
		Timing WAT					
		2	4	6	10	14	16
Aminocyclopyrachlor	49	79 a	96 a	99 a	99 a	99 a	99 a
Aminocyclopyrachlor	98	83 a	98 a	99 a	99 a	99 a	99 a
Aminocyclopyrachlor + 2,4-D	49 + 371	81 a	96 a	99 a	99 a	97 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	86 a	99 a	99 a	99 a	99 a	99 a
Aminopyralid	88	84 a	97 a	98 a	98 a	96 a	97 b
Untreated Check		0 b	0 b	0 b	0 b	0 b	0 c
LSD (0.05)		9	4	1	1	3	1

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.36 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2010, LPOST

Herbicide Treatments	Rate (g ai/ha)	Tall Ironweed Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	48 a	70 a	78 a
Aminocyclopyrachlor	98	54 a	71 a	83 a
Aminocyclopyrachlor + 2,4-D	49 + 371	50 a	68 a	79 a
Aminocyclopyrachlor + 2,4-D	98 + 742	58 a	74 a	88 a
Aminopyralid	88	54 a	76 a	82 a
Untreated Check		0 b	0 b	0 b
LSD (0.05)		14	10	10

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.37 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, End of Season
Pulaski, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	7 a	51.6 a	115.75 a	62.91 a
¹ Aminocyclopyrachlor	49	99 a	0 a	0 a	0 a	0 b
¹ Aminocyclopyrachlor	98	99 a	0 a	0 a	0 a	0 b
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 a	0 a	0 a	0 b
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 a	0 a	0 a	0 b
¹ Aminopyralid	88	97 a	0 a	0 a	0 a	0 b
² Aminocyclopyrachlor	49	78 b	4.3 a	60.5 a	71.93 a	38.4 ab
² Aminocyclopyrachlor	98	83 b	5.8 a	43.2a	34.05 a	23.23 ab
² Aminocyclopyrachlor + 2,4-D	49 + 371	79 b	3.8 a	36.8 a	55.75 a	27.24 ab
² Aminocyclopyrachlor + 2,4-D	98 + 742	88 b	1.8 a	31.8 a	25.5 a	16.24 ab
² Aminopyralid	88	82 b	2.8 a	26.2 a	22.15 a	9.27 b
Untreated Check		0 c	0.5 a	5.1 a	1.83 a	0.93 b
LSD (0.05)		8	4.3	35.7	69.0	33.69

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Late-postemergent (LPOST)

Table 3.38 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2010, 1 YAT
Pulaski, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	24.3 a	68.6 ab	743.5 a	338 a
¹ Aminocyclopyrachlor	49	99 a	0 b	0 c	0 b	0 b
¹ Aminocyclopyrachlor	98	97 a	0.8 b	4.6 c	4.5 b	1.3 b
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	86 ab	1.5 b	6.4 c	13.8 b	3.8 b
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 b	0 c	0 b	0 b
¹ Aminopyralid	88	82 ab	7.3 b	19.8 c	56.3 b	20.8 b
² Aminocyclopyrachlor	49	98 a	0 b	0 c	0 b	0 b
² Aminocyclopyrachlor	98	99 a	0 b	0 c	0 b	0 b
² Aminocyclopyrachlor + 2,4-D	49 + 371	93 a	0 b	0 c	0 b	0 b
² Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 b	0 c	0 b	0 b
² Aminopyralid	88	74 b	6.8 b	51.6 b	118.5 b	44.8 b
Untreated Check		0 c	18.8 a	82 a	773 a	339.8 a
LSD (0.05)		12	9.2	24.8	244	128.2

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Late-postemergent (LPOST)

Table 3.39 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2011, EPOST

Herbicide Treatments	Rate(g ai/ha)	Tall Ironweed Control (%)					
		Timing WAT					
		2	4	6	10	14	16
Aminocyclopyrachlor	49	87 a	95 a	99 a	99 a	99 a	99 a
Aminocyclopyrachlor	98	87 a	96 a	99 a	99 a	99 a	99 a
Aminocyclopyrachlor + 2,4-D	49 + 371	85 a	94 a	99 a	99 a	99 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	87 a	96 a	99 a	99 a	99 a	99a
Aminopyralid	88	88 a	93 a	97 a	97 a	95 b	97 a
Untreated Check		0 b	0 b	0 b	0 b	0 c	0 b
LSD (0.05)		5	5	1	2	1	2

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.40 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, London, KY 2011, LPOST

Herbicide Treatments	Rate (g ai/ha)	Tall Ironweed Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	45 a	71 a	73 a
Aminocyclopyrachlor	98	60 a	83 a	82 a
Aminocyclopyrachlor + 2,4-D	49 + 371	45 a	70 a	80 a
Aminocyclopyrachlor + 2,4-D	98 + 742	58 a	79 a	85 a
Aminopyralid	88	63 a	76 a	77 a
Untreated Check		0 b	0 b	0 b
LSD (0.05)		16	10	10

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.41 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2011, End of Season
London, KY

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 d	16 a	95.3 a	338.8 a	125 a
¹ Aminocyclopyrachlor	49	99 a	0 c	0 c	0 b	0 b
¹ Aminocyclopyrachlor	98	99 a	0 c	0 c	0 b	0 b
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	99 a	0 c	0 c	0 b	0 b
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	99 a	0 c	0 c	0 b	0 b
¹ Aminopyralid	88	97 a	0 c	0 c	0 b	0 b
² Aminocyclopyrachlor	49	73 c	6.5 bc	80 ab	111.5 b	47.8 b
² Aminocyclopyrachlor	98	81 bc	6.5 bc	57.2 ab	72.5 b	37 b
² Aminocyclopyrachlor + 2,4-D	49 + 371	80 bc	8.3 bc	69.9 ab	99.3 b	35.8 b
² Aminocyclopyrachlor + 2,4-D	98 + 742	85 b	7.3 bc	54.1 ab	77.8 b	35.8 b
² Amiopyralid	88	77 bc	4.5 c	35.1 bc	64.3 b	26 b
Untreated Check		0 d	13 ab	92.2 a	324.3 a	128.3 a
LSD (0.05)		8	5.1	33	79.1	31

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Late-postemergent (LPOST)

Table 3.42 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Maynardville, TN 2011, EPOST

Herbicide Treatments	Rate (oz ai/a)	Tall Ironweed Control (%)				
		Timing WAT				
		2	4	6	10	14
Aminocyclopyrachlor	49	80 ab	89 b	99 a	99 a	99
Aminocyclopyrachlor	98	84 a	92 ab	99 a	99 a	99
Aminocyclopyrachlor + 2,4-D	49 + 371	77 b	93 ab	99 a	99 a	99
Aminocyclopyrachlor + 2,4-D	98 + 742	83 ab	99 a	99 a	99 a	99
Aminopyralid	88	83 ab	91 ab	98 a	98 a	99
Untreated Check		0 c	0 c	0 b	0 b	0
LSD (0.05)		4	6	1	1	**

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

**No variance between replications within treatments. Means separation unnecessary.

Table 3.43 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Maynardville, TN 2011, MPOST

Herbicide Treatments	Rate (oz ai/a)	Tall Ironweed Control (%)			
		Timing WAT			
		4	8	10	12
Aminocyclopyrachlor	49	87 a	99	99 a	99 a
Aminocyclopyrachlor	98	94 a	99	99 a	99 a
Aminocyclopyrachlor + 2,4-D	49 + 371	88 a	99	99 a	99 a
Aminocyclopyrachlor + 2,4-D	98 + 742	90 a	99	99 a	99 a
Aminopyralid	88	89 a	99	99 a	98 a
Untreated Check		0 b	0	0 b	0 b
LSD (0.05)		7	**	1	1

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

**No variance between replications within treatments. Means separation unnecessary.

Table 3.44 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Maynardville, TN 2011, LPOST

Herbicide Treatments	Rate (oz ai/a)	Tall Ironweed Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	74 a	86 a	85 a
Aminocyclopyrachlor	98	73 a	87 a	90 a
Aminocyclopyrachlor + 2,4-D	49 + 371	69 a	83 a	91 a
Aminocyclopyrachlor + 2,4-D	98 + 742	72 a	89 a	94 a
Aminopyralid	88	75 a	86 a	90 a
Untreated Check		0 b	0 b	0 b
LSD (0.05)		9	7	8

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.45 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2011, End of Season
Maynardville, TN

Herbicide Treatments	Rate oz ai/a	Control %	Count /sq. m	Height in.	Fresh Wt. g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 c	19.8 a	5.5 ab	45.2 b	13 ab
¹ Aminocyclopyrachlor	49	99 a	0 c	0 b	0 c	0 b
¹ Aminocyclopyrachlor	98	99 a	0 c	0 b	0 c	0 b
¹ Aminocyclopyrachlor+2,4-D	49 + 371	99 a	0 c	0 b	0 c	0 b
¹ Aminocyclopyrachlor+2,4-D	98 + 742	99 a	0 c	0 b	0 c	0 b
¹ Aminopyralid	88	99 a	0 c	0 b	0 c	0 b
² Aminocyclopyrachlor	49	99 a	0 c	0 b	0 c	0 b
² Aminocyclopyrachlor	98	99 a	0 c	0 b	0 c	0 b
² Aminocyclopyrachlor+2,4-D	49 + 371	99 a	0 c	0 b	0 c	0 b
² Aminocyclopyrachlor+2,4-D	98 + 742	99 a	0 c	0 b	0 c	0 b
² Aminopyralid	88	98 a	0.5 c	1.3 b	1.1 c	0.3 b
³ Aminocyclopyrachlor	49	86 b	10.5 abc	3.5 ab	28.2 bc	17.3 ab
³ Aminocyclopyrachlor	98	87 b	7.5 bc	5.3 ab	20.2 bc	8 ab
³ Aminocyclopyrachlor+2,4-D	49 + 371	83 b	2.5 c	10 a	22 bc	7.8 ab
³ Aminocyclopyrachlor+2,4-D	98 + 742	89 b	0.8 c	2.3 ab	3.8 c	1 b
³ Aminopyralid	88	86 b	8.3 bc	3 ab	18.3 bc	4.8 b
Untreated Check		0 c	16 ab	7.8 ab	72.1 a	25.8 a
LSD (0.05)		5	8.2	5.3	25.1	13.6

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Mid-postemergent (MPOST)

³Late-postemergent (LPOST)

Table 3.46 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2011, EPOST

Herbicide Treatments	Rate(g ai/ha)	Tall Ironweed Control (%)						
		Timing WAT						
		2	4	6	10	14	18	21
Aminocyclopyrachlor	49	77 ab	80 b	90 ab	89 a	93 a	91 a	94 a
Aminocyclopyrachlor	98	79 ab	86 ab	95 a	91 a	97 a	98 a	98 a
Aminocyclopyrachlor +2,4-D	49 + 371	82 a	86 ab	89 b	90 a	92 a	92 a	90 ab
Aminocyclopyrachlor +2,4-D	98 + 742	84 a	89 a	95 a	96 a	98 a	98 a	98 a
Aminopyralid	88	71 b	74 c	77 c	85 a	79 b	81 b	84 b
Untreated Check		0 c	0 d	0 d	0 b	0 c	0 c	0 c
LSD (0.05)		7	6	4	11	8	7	7

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.47 Utility of Aminocyclopyrachlor for Control of Tall Ironweed, Pulaski, TN 2011, LPOST

Herbicide Treatment	Rate (g ai/ha)	Tall Ironweed Control (%)		
		Timing WAT		
		2	4	6
Aminocyclopyrachlor	49	53 a	74 a	73 a
Aminocyclopyrachlor	98	59 a	81 a	81 a
Aminocyclopyrachlor + 2,4-D	49 + 371	51 a	70 a	73 a
Aminocyclopyrachlor + 2,4-D	98 + 742	60 a	82 a	79 a
Aminopyralid	88	50 a	80 a	70 a
Untreated Check		0 b	0 b	0 b
LSD (0.05)		8	9	9

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 3.48 Utility of Aminocyclopyrachlor for Control of Tall Ironweed in 2011, End of Season
Pulaski, TN

Herbicide Treatments	Rate g ai/ha	Control %	Count /sq. m	Height cm	Fresh Wt. ³ g/sq. m	Dry Wt. g/sq. m
Untreated Check		0 f	11.3 abc	85.9 ab		155.5 ab
¹ Aminocyclopyrachlor	49	94 ab	0.8 bc	23.6 bcd		5.5 c
¹ Aminocyclopyrachlor	98	98 a	0 c	0 d		0 c
¹ Aminocyclopyrachlor + 2,4-D	49 + 371	90 abc	1 bc	16 cd		1.5 c
¹ Aminocyclopyrachlor + 2,4-D	98 + 742	98 a	0 c	0 d		0 c
¹ Aminopyralid	88	84 bc	4.3 bc	39.4 a-d		26 c
² Aminocyclopyrachlor	49	73 de	15.3 a	106.7 a		199.3 a
² Aminocyclopyrachlor	98	81 cd	7.8 abc	60.5 a-d		52 bc
² Aminocyclopyrachlor + 2,4-D	49+ 371	73 de	5.5 abc	95.3 a		90.5 abc
² Aminocyclopyrachlor + 2,4-D	98 + 742	79 cde	5 abc	55.4 a-d		46.8 bc
² Aminopyralid	88	70 e	7 abc	73.2 abc		48.5 bc
Untreated Check		0 f	11.8 ab	92.7 a		109.8 abc
LSD (0.05)		8	6.9	44.2		83.6

*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

¹Early-postemergent (EPOST)

²Late-postemergent (LPOST)

³Fresh weight data not available for this location in 2011.

VITA

Mr. Phillips was born and raised in East Tennessee. He grew up in Scott County, and attended Tennessee Technological University in Cookeville after graduating from high school. After earning a Bachelor of Science degree in Agriculture with a concentration in Agronomy and Soils from Tennessee Tech, he began pursuing a Master of Science degree in Plant Sciences at the University of Tennessee.